

FINITE ELEMENT METHODS FOR FLUID DYNAMICS WITH MOVING BOUNDARIES AND INTERFACES

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We provide an overview of the finite element methods we developed in recent years for computation of fluid dynamics problems with moving boundaries and interfaces. This class of problems include those with free surfaces, two-fluid interfaces, fluid-object and fluid-structure interactions, and moving mechanical components. The methods developed can be classified into two main categories: interface-tracking and interface-capturing techniques. Both classes of techniques are based on stabilized formulations, and determination of the stabilization parameters used in these formulations is also highlighted here. The interface-tracking techniques are based on the Deforming-Spatial-Domain/Stabilized Space-Time (DSD/SST) formulation, where the mesh moves to track the interface. The interface-capturing techniques were developed for two-fluid flows. They are based on the stabilized formulation, over typically non-moving meshes, of both the flow equations and an advection equation. The advection equation governs the time-evolution of an interface function marking the interface location. We also describe some of the additional methods we developed to increase the scope and accuracy of these two classes of techniques. Among them are the Enhanced-Discretization Interface-Capturing Technique (EDICT), which was developed to increase the accuracy in capturing the interface, extensions and offshoots of the EDICT, and mixed solution techniques. The overview of these techniques is supplemented by a number numerical examples from computation of complex flow problems.